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Time Value of Money and Income Tax Evasion Under Risk-Averse Behavior: Theoretical Analysis and Empirical Evidence

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TIME VALUE OF MONEY AND INCOME TAX EVASION UNDER RISK-AVERSE BEHAVIOR: THEORETICAL ANALYSIS AND EMPIRICAL EVIDENCE*

by

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I. INTRODUCTION

In the years since the original work by Allingham and Sandmo [1972], income tax evasion has been analyzed extensively. Most of the work has been theoretical in nature. However, a number of empirical studies have also appeared in the professional literature. This paper contains both types of analysis. From a theoretical perspective, we are interested in extending the traditional evasion framework so as to incorporate the possible effect of interest rates on a risk-averse individual's decision to evade. Empirically, we attempt to provide, at an aggregate level, some evidence regarding the nature of this relationship, as well as the relationship between evasion and its other major determinants.

Despite the extensive literature on tax evasion, little attention has been given to the possible role of interest rates. It is somewhat surprising that this issue has not been pursued. It represents a natural extension of the simple dynamic model considered briefly by Allingham and Sandmo [1972] in the final section of their seminal article. That model permitted them to establish that most of the implications of their static model held in the dynamic case. But because of its simplicity (e.g., the individual was assumed to have no time preference), they cautioned that their dynamic results should be considered as tentative, and encouraged additional research in this area.

As far as we know, only Sproule, Komus, and Tsang [1980] and Rickard, Russell, and Howroyd [1982], have included interest rates in their models. While both of these models provide valuable insights into the evasion problem, they are not primarily concerned with the role of interest rates. The former analyzes evasion under a negative income tax system, while the latter focuses on the role of retroactive penalties. Further, both consider the special case of a risk-neutral individual. Thus, neither treatment of the role of interest rates is completely satisfactory, and additional analysis is warranted.

On an intuitive level, it is easy to see how interest rates might affect the individual's assessment of the expected costs and benefits of evasion. Income that is successfully unreported can be invested in order to generate additional future income. Other things equal, this increases the return to successful underreporting, which, ignoring risk attitudes, should cause evasion to increase. On the other hand, the cost of unsuccessful evasion includes not only additional taxes and penalties, but also interest charges. Other things equal, higher interest rates increase the cost of unsuccessful evasion, and, ignoring risk considerations, should cause evasion to decrease. The individual's actual response depends on which of these two effects dominates, as well as on his/her attitude towards risk.

Although the direction in which interest rates may affect tax evasion cannot be determined intuitively, certain insights may be gained from recognizing the possibility of tax avoidance and its probable interaction with tax evasion. *Ceteris paribus*, an increase in the interest rate may be expected to increase tax avoidance. This is because higher interest rates increase the return to avoidance without increasing the associated costs, since avoidance, a legal activity, is not subject to penalties. To the extent that avoidance and evasion are complementary, increased avoidance should be accompanied by increased evasion. However, if the two activities are substitutes, then no inference can be drawn regarding the effect of interest rates on tax evasion.¹ This underscores the need for a formal analysis of the effect of interest rates on income tax evasion.

The remainder of this paper is organized as follows. In the next section we develop a simple theoretical model of income tax evasion that explicitly considers the role of interest rates under risk-averse behavior. This is followed by Section III, where we specify and estimate an empirical evasion equation based on this theoretical model using time-series data for the U.S. In the final section, we summarize our findings.

II. THE THEORETICAL MODEL

In developing our model of tax evasion, we follow the general framework suggested by Yitzhaki [1974]. This choice was influenced by the fact that in Yitzhaki's model penalties are based on evaded taxes, as is the current practice in the U.S.² However, we modify Yitzhaki's model in three ways. First, in order to explicitly incorporate interest rates, we replace current income with permanent income, which we define as the present value of the lifetime stream of income. Second, we allow for the effect of inflation by including prices in the model.³ To date, only Fishburn [1981] has considered this issue. Third, we specify the individual's decision variable in terms of the proportion of true income that is to be underreported, rather than the level of reported income as in Yitzhaki [1974]. This

allows us to compare our results with respect to the effect of interest rates and prices with those reported by Sproule, Komus, and Tsang [1980], and Fishburn [1981], respectively.

Consider a risk-averse individual with a cardinal utility function, U , defined over the present value of real lifetime income, $Q = \sum(y_t/p)(1+r)^{-t}$, where y_t is income in period $t = 0, 1, \dots, n$, p is the price deflator, and r is the individual's rate of time preference. Make the standard assumptions that $U(Q) > 0$, $U'(Q) > 0$, and $U''(Q) < 0$, for all $Q > 0$. The taxpayer faces an income tax rate, $0 < \theta < 1$, and has to decide whether, and to what extent to evade taxes. If the taxpayer chooses to evade, he/she is assumed to underreport his/her true income by a constant fraction, λ . The taxpayer's subjective assessment of the probability of getting caught is $0 < \Pi < 1$. Detected evaders are subjected to a penalty rate, $\delta > 1$, which is imposed on evaded taxes.

With probability Π the evader will be detected, in which case his/her real income after taxes and penalties will be

$$(1) \quad Z_1 = \sum(1/p)[y_t - \theta(1-\lambda)y_t](1+r)^{-t} - \delta\sum(1/p)\theta\lambda y_t(1+r)^{-t}$$

On the other hand, with probability $(1 - \Pi)$ the evader will go undetected and will enjoy real disposable income of

$$(2) \quad Z_2 = \sum(1/p)[y_t - \theta(1-\lambda)y_t](1+r)^{-t}$$

The taxpayer chooses the proportion of income that is to be underreported, λ , so as to maximize expected utility

$$(3) \quad E[U(Q)] = \Pi U(Z_1) + (1 - \Pi)U(Z_2)$$

Differentiating (3) with respect to λ , and using (1) and (2), we get the necessary condition for an extremum

$$(4) \quad \frac{\partial E(U)}{\partial \lambda} = \theta \sum \left(\frac{1}{p} \right) y_t (1+r)^{-t} [\Pi(1-\delta)U'(Z_1) + (1-\Pi)U'(Z_2)] = 0$$

which can be written in an implicit form as

$$(5) \quad \Phi(\lambda, \Pi, \delta, \theta, y, p, r)$$

Differentiating (4) with respect to λ , we obtain the sufficient condition for a maximum,

$$(6) \quad \frac{\partial^2 E(U)}{\partial \lambda^2} = \theta^2 \left[\sum \left(\frac{1}{p} \right) y_t (1+r)^{-t} \right]^2 [\Pi(1-\delta)^2 U''(Z_1) + (1-\Pi)U''(Z_2)] \equiv D$$

which is strictly negative under the previously stated assumptions. We have thus

established the existence of a unique solution to the taxpayer's optimization problem.

Because we are interested in the comparative static implications of the model, it is essential to examine the restrictions that must be placed on its parameters in order to obtain an interior solution. Since expected marginal utility is decreasing, we must have that

$$(7) \quad \Phi(0, \Pi, \delta, \Theta, y_i, p, r) = \Theta \Sigma(\frac{1}{p}) y_i (1+r)^{-1} (1-\delta \Pi) U'[\Sigma(\frac{1}{p})(y_i - \Theta y_i)(1+r)^{-1}] > 0$$

which requires

$$(8) \quad \delta \Pi < 1$$

Moreover, we must have that

$$(9) \quad \Phi(1, \Pi, \delta, \Theta, y_i, p, r) = \Theta \Sigma(\frac{1}{p}) y_i (1+r)^{-1} \{ \Pi (1-\delta) U'[\Sigma(\frac{1}{p})(y_i - \Theta \delta y_i)(1+r)^{-1}] + (1-\Pi) U'[\Sigma(\frac{1}{p}) y_i (1+r)^{-1}] \} < 0$$

which is satisfied as long as

$$(10) \quad \Pi + (1-\Pi) \left\{ \frac{U'[\Sigma(\frac{1}{p}) y_i (1+r)^{-1}]}{U'[\Sigma(\frac{1}{p})(y_i - \Theta \delta y_i)(1+r)^{-1}]} \right\} < \delta \Pi$$

Note that the left-hand side of (10) is a (positive) fraction so that there is no contradiction with (8). Thus, (8) and (10) provide a set of conditions for the existence of a unique interior solution, λ_0 , to the taxpayer's evasion problem.

We are now in a position to conduct comparative static analysis of the effect of variations in the parameters of the model. Let us begin with the effect of the probability of detection, Π . Differentiating (5) with respect to Π using (4), and applying the Implicit Function Theorem (IFT) using (6), we have

$$(11) \quad \frac{\partial \lambda_0}{\partial \Pi} = - \left(\frac{1}{D} \right) \Theta \Sigma(\frac{1}{p}) y_i (1+r)^{-1} [(1-\delta) U'(Z_1) - U'(Z_2)]$$

which is strictly negative, given (6) and the assumptions of the model. Thus, higher probabilities of detection result in a lower proportion of income underreported.

Let us next consider the effect of the other compliance policy tool, the penalty rate, δ . This requires differentiating (5) with respect to δ using (4), and applying the IFT using (6) to get

$$(12) \quad \frac{\partial \lambda_0}{\partial \delta} = - \left(\frac{1}{D} \right) \Theta \Pi \Sigma(\frac{1}{p}) y_i (1+r)^{-1} [\Theta \lambda (\delta - 1) \Sigma(\frac{1}{p}) y_i (1+r)^{-1} U''(Z_1) - U'(Z_2)]$$

which is strictly negative in view of (6) and the assumptions of the model. Thus, other things equal, higher penalty rates result in a lower proportion of income underreported. This result, along with that pertaining to the detection probability, is consistent with most models in the literature (e.g., Allingham and Sandmo [1972], Fishburn [1981], Srinivasan [1973]).

Let us now examine the effect of the tax rate, Θ , on λ_0 . Differentiating (5) with respect to Θ using (4), and applying the IFT using (6), we obtain

$$(13) \quad \frac{\partial \lambda_0}{\partial \Theta} = - \left(\frac{1}{D} \right) \Theta (1 - \Pi) \left[\Sigma \left(\frac{1}{p} \right) y_i (1+r)^{-1} \right]^2 U'(Z_2) [(1-\lambda) R_a(Z_2) - (1-\lambda+\delta\lambda) R_a(Z_1)]$$

where $R_a(Z) = -U''(Z)/U'(Z)$ is Arrow's [1971] measure of absolute risk aversion. Clearly, the sign of (13) depends on the sign of the second bracket. This is in line with Yitzhaki's [1974] finding that, when taxes are proportional and penalties are imposed on evaded taxes, changes in the tax rate generate only an income effect whose sign depends on the properties of the absolute risk aversion function. Since $\delta\lambda > 0$, under Arrow's Hypothesis of decreasing absolute risk aversion, (13) is negative, implying that higher taxes lead to lower proportional underreporting. This, too, is consistent with Yitzhaki's finding that, ignoring the time value of money, higher tax rates result in higher levels of reported income. Note that Arrow's Hypothesis is only a sufficient condition for a negative relationship between the tax rate and the optimal proportion of income underreported.

Turning to the effect of true income, y_i , we have that

$$(14) \quad \frac{\partial \lambda_0}{\partial y} = - \left(\frac{1}{D} \right) \Theta (1 - \Pi) \Sigma \left(\frac{1}{p} \right) (1+r)^{-1} U'(Z_2) [R_r(Z_1) - R_r(Z_2)]$$

where $R_r(Z) = -[U''(Z)/U'(Z)]Z$ is Arrow's [1971] measure of relative risk aversion. Under Arrow's Hypothesis of increasing relative risk aversion, (14) is negative, implying that higher levels of true income lead to reduced proportional underreporting, *ceteris paribus*. This result is consistent with the finding of Allingham and Sandmo [1972] and Fishburn [1981], among others. Note that in this case Arrow's Hypothesis is both necessary and sufficient for the negative relationship between income and λ_0 .

Let us next consider the effect of inflation on λ_0 . Differentiating (5) with respect to p using (4), and applying the IFT using (6), we obtain

$$(15) \quad \frac{\partial \lambda_0}{\partial p} = - \left(\frac{1}{D} \right) \Theta (1 - \Pi) \Sigma \left(\frac{1}{p} \right) y_i (1+r)^{-1} U'(Z_2) [R_r(Z_2) - R_r(Z_1)]$$

Clearly, under Arrow's Hypothesis of increasing relative risk aversion, (15) is unambiguously positive, indicating that higher prices lead to higher proportional underreporting. This is consistent with Fishburn's [1981] finding.

Finally, let us examine the effect of the variable which is of particular interest to us, the rate of interest, r . Differentiating (5) with respect to r using (4), and applying the IFT using (6), we get

$$(16) \quad \frac{\partial \lambda_0}{\partial r} = - \left(\frac{1}{D} \right) \Theta (1 - \Pi) \Sigma \left(\frac{1}{p} \right) t y_i (1 + r)^{-1} [R_i(Z_2) - R_i(Z_1)]$$

Under Arrow's Hypothesis of increasing relative risk aversion, (16) is positive, implying that higher interest rates lead to increased proportional underreporting, *ceteris paribus*. It is interesting to note that under the assumption of risk aversion we are able to obtain this conditional result. However, if risk neutrality is assumed, the partial derivative of λ_0 with respect to r is sign ambiguous, as in Sproule, Komus, and Tsang [1980, p. 313].

To summarize, our simple model indicates the following. First, regardless of the properties of the risk aversion functions, there is an unambiguously negative relationship between optimal proportional underreporting, λ_0 , and both the detection probability and the penalty rate. Second, if one is willing to subscribe to Arrow's Hypothesis of decreasing absolute risk aversion, one would expect a negative relationship between λ_0 and the tax rate. However, this hypothesis is only a sufficient condition for such a relationship. Third, under Arrow's Hypothesis of increasing relative risk aversion one would expect (i) a negative relationship between true income and λ_0 , (ii) a positive relationship between inflation and λ_0 , and (iii) a positive relationship between interest rates and λ_0 . Note that here Arrow's Hypothesis is both a necessary and a sufficient condition.

We are now in a position to conduct our empirical analysis. Where the theoretical results are unconditionally determinant, this empirical analysis should provide confirmation or refutation. Where the theoretical findings are conditional, we hope our empirical analysis will offer some insight into the nature of the relationships in question.

III. AGGREGATE EMPIRICAL ANALYSIS

Several problems are encountered when conducting aggregate empirical analysis of the effect of interest rates on evasion. First, it is difficult to obtain accurate measures of evasion since it is an unobserved phenomenon. Second, our focus on the effect of interest rates requires us to use time-series data, thereby limiting our choice of an evasion measure even further. Third, our interest in aggregate analysis poses not only the usual aggregation problems, but also the additional difficulty of aggregating risk aversion.

Fortunately, these problems are not insurmountable. Despite the measurement problems, several attempts have been made to estimate the extent of tax evasion in

the U.S. These are reviewed and critically evaluated by Frey and Pommerehne [1982]. Of these measures some are time series spanning a period of sufficient length, thereby making them suitable for our purposes. Moreover, both aggregation problems can be overcome. First, aggregate counterparts of the arguments in (5) can be developed, as discussed in Appendix A. Second, the recent work by Szpiro [1983] provides a theoretical justification for the aggregation of risk aversion.⁴ Therefore, a link can be established between the microfoundations laid out in the previous section and the aggregate analysis we wish to undertake.

Based on the theoretical framework formulated in Section II, we specify the following aggregate empirical counterpart of the implicit evasion function given in (5)

$$(17) \quad \lambda_t = a_0 + a_1 \Pi_t + a_2 \delta_t^* + a_3 \Theta_t + a_4 \ln y_t^* + a_5 \dot{p}_t \\ + a_6 r_t + a_7 w_t + a_8 t + \epsilon_t$$

where w is the wage and salary share of total income, t is an annual time index, the asterisk indicates that the corresponding variable has been instrumented as discussed in Appendix A, the dot represents proportionate rate of change, and all other notations are as defined in Section II.⁵

Note that (17) differs from (5) in several ways. First, it contains an additional right-hand-side variable, w . This is included to allow for the fact that in the U.S. wage-and-salary income is difficult to conceal, due to tax information reporting by employers (see, for example, Clotfelter [1983] and Tanzi [1980]). Second, the income variable in (17) is expressed in logarithmic form in order to allow for nonlinearities that may arise from risk-averse behavior. Third, (17) is specified in terms of the rate of inflation, rather than the price level. Perhaps, a more consistent specification of the price variable would be to express it in logarithmic form. But given the specification of the income variable, this would cause severe multicollinearity problems. Although several econometric techniques for handling this problem are available, we do not believe the results could be as meaningfully interpreted. This means that no inference can be drawn from our theoretical model regarding the expected sign of the coefficient of \dot{p} .

Equation (17) was estimated using the Cochrane-Orcutt second-order autoregressive procedure. The results are presented below, where the numbers in parentheses are t -statistics.

$$(18) \quad \hat{\lambda}_t = 16.56 - 0.02 \Pi_t - 0.07 \delta_t^* + 0.07 \Theta_t - 0.10 \ln y_t^* \\ (6.00) \quad (-0.53) \quad (-4.16) \quad (3.81) \quad (-6.14) \\ + 0.68 \dot{p}_t + 0.66 r_t - 0.09 w_t - 0.34 t \\ (9.79) \quad (8.08) \quad (-2.52) \quad (-3.05)$$

$$\bar{R}^2 = 0.92$$

$$\hat{\rho}_1 = -0.45, \\ (-3.91)$$

$$\hat{\rho}_2 = -0.75 \\ (-6.51)$$

$$DW = 2.07$$

It is evident from equation (18) that our model successfully captures the postulated aggregate evasion relationship. With one exception, all parameter estimates are statistically significant, and the adjusted R^2 indicates that ninety-two percent of the overall variation in the proportion of income underreported has been explained by the model.

Let us begin our discussion of the results with an examination of the interest rate variable. From (18) we see that interest rates are positively related to the proportion of income unreported, and that this relationship is statistically significant. Based on the coefficient of the rate of interest, a one percentage point increase in r results in more than 0.66 percentage point increase in proportional underreporting, λ . This suggests that, other things equal, U.S. taxpayers have found, on average, that the expected gain from investing unreported income to be greater than the expected interest cost associated with unsuccessful evasion. This may be explained, at least in part, by the fact that in the U.S. penalties imposed on detected evaders are not fully retroactive.⁶

The positive relationship between interest rates and underreporting also has an interesting implication for fiscal policy. It has long been argued that bond-financed fiscal policy generates higher interest rates which crowd out private spending. This makes fiscal policy less effective and adds to the deficit by increasing the interest cost of servicing the national debt. Our finding indicates that the deficit-induced higher interest rates lead, *ceteris paribus*, to more evasion, less tax revenue, and therefore a further increase in the deficit. In other words, tax evasion represents another channel through which the crowding-out effect adversely influences the budget.

Next we consider our findings for the other variables in our empirical model. In general, we find significant coefficient estimates whose signs are consistent with our theoretical expectations or with previous empirical work. Both the penalty rate and the wage share variables are negatively related to the measure of evasion used here. However, the detection probability, while having the expected negative sign, is not statistically significant. This may be due to the failure of our proxy measure to adequately capture this inherently subjective variable.

Turning to the effect of the tax rate, we find a direct relationship. This contrasts with our theoretical expectations, but it is consistent with the empirical finding reported by Clotfelter [1983], among others. A possible explanation for this direct relationship is as follows. While our simple theoretical model employs a

proportional tax function, our empirical model pertains to an economy with progressive taxes. With progressive taxes, changes in tax rates affect the labor-leisure and saving-consumption decisions, producing both substitution and income effects. To the extent that the substitution effect dominates the income effect, higher taxes result in increased evasion.

In the case of the income variable, a negative and statistically significant coefficient is obtained. This has an interesting implication. Recall from (14) that Arrow's Hypothesis of increasing relative risk aversion is both necessary and sufficient for a negative relationship between income and underreporting. Further recall from (16) that this hypothesis is also necessary and sufficient for a positive relationship between interest rates and underreporting. Coupled with the above finding that interest rates and underreporting are positively related, our results with respect to income provide some support for the hypothesis of increasing relative risk aversion.

As for the effect of changes in the inflation rate, our results indicate a positive link. This, too, has an interesting implication. It is often argued that because of the bracket-creep effect, inflation enhances tax revenue. However, in view of the positive relationship found here, the net effect of inflation on tax revenues may not be as significant as is generally believed.

Finally, according to equation (18), proportional underreporting in the U.S. has had a negative trend over the period of study. Coupled with the fact that the level of aggregate unreported income has been rising over the same period, this finding means that in absolute terms, tax evasion has grown less rapidly than income. This is consistent with the above result that proportional underreporting falls as income rises.

IV. SUMMARY

In this paper we examined the effect of interest rates on tax evasion in the U.S. We began by developing a simple theoretical model which explicitly incorporated the role of interest rates under risk-averse behavior. In addition to interest rates, this model considered the effect on evasion of the probability of detection, the penalty rate, the tax rate, the level of true income, and the price level.

Our comparative static analysis led to the conclusion that the direction of the relationship between interest rates and evasion depended upon attitude towards risk. Under the hypothesis of increasing relative risk aversion advanced by Arrow, we found that a direct relation can be expected from interest rates to the proportion of income underreported. Results consistent with those reported in previous theoretical literature were obtained for the other variables.

To provide additional insight, we conducted an aggregate empirical analysis for the U.S. over the period 1947-81. The results indicated that evasion and interest rates were indeed directly related. They also supported previous empirical findings regarding the relationship between evasion and its other major determinants.

NOTES

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¹ We wish to thank an anonymous referee for pointing out the effect of interest rates on tax avoidance, and its possible implication for tax evasion. For a theoretical analysis of the interaction between income tax evasion and tax avoidance, see Cross and Shaw [1982].

² Except for the penalty base, Yitzhaki's model is similar to that of Allingham and Sandmo [1972]. Like many evasion models, Yitzhaki's employs a number of simplifying assumptions. For example, it assumes a detection probability independent of income, as well as proportional tax and penalty functions. While these and other complexities could be incorporated into the model, (as in, for example, Fishburn [1981], Koskela [1983], and Srinivasan [1973]), we have chosen not to do so in order to keep the exposition simple.

³ The rationale for including the price level in a model of tax evasion is as follows. Price changes erode the real value of a given level of nominal disposable income, thereby providing an incentive for the taxpayer to preserve his/her purchasing power through evasion. For more on this, see Fishburn [1981].

⁴ Although Szpiro's analysis is in terms of absolute risk aversion, it seems plausible that the same general conclusion holds for the case of relative risk aversion. This is a topic of current interest to the authors.

⁵ Note that (17) is a reduced-form equation. We chose that approach because our primary interest is in testing the interest rate-evasion hypothesis. Clearly, if one wished to trace the effect of tax evasion through the macro economy, one would have to employ an appropriate structural model. For a theoretical analysis of the general equilibrium effects of tax evasion, see Peacock and Shaw [1982], and Ricketts [1984].

⁶ In this case, the U.S. Tax Code provides for a statute of limitations of three to six years.

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APPENDIX A

VARIABLE DEFINITIONS

In this appendix we develop the aggregate empirical counterparts of the arguments in (5) which are used in (17), provide the rationale for their selection, and indicate how we handle several potential econometric problems.

PROPORTIONAL UNDERREPORTING, λ . Our analysis requires aggregate time-series data for the U.S. spanning a period of sufficient length. As far as we know, only two data series meet this requirement: Tanzi's [1980] estimates of evaded taxes and Park's estimates of unreported income. Unfortunately, because the former estimates were obtained from an econometric model which included some of the explanatory variables used in (17), Tanzi's estimates cannot be used for our dependent

variable. Therefore, we base our dependent variable on Park's estimates of the Adjusted Gross Income (AGI) Gap.

The AGI Gap is the AGI figure derived by the Bureau of Economic Analysis (BEA) from the National Income Accounts minus the AGI figure reported by the Internal Revenue Service (IRS). The former is a proxy for reportable income while the latter is income actually reported to the tax authorities. Therefore, the Gap is a measure of the nondeclared income received in the official ("above ground") economy, and does not include "underground" income flows from criminal activity, etc.

However, because the AGI Gap includes income of those not legally required to file tax returns, we adjust the Gap by removing from it an imputed value of the AGI of those not required to file tax returns. To accomplish this, we follow an approach used by Goode [1976]. This involves using exemption data to estimate the percentage of the population not covered by tax returns, and assuming that the income of this group equals, on average, that reported on nontaxable returns. The adjusted Gap is then expressed as a percentage of the income measure defined below.

PROBABILITY OF DETECTION, Π . This variable is calculated as the moving average of the current, one-year, and two-year lagged values of the percentage of total tax returns audited each year by the IRS. The reason for using this moving average is as follows. An individual's subjective evaluation of the probability of being detected may, in part, depend on whether or not he/she knows someone who has been audited recently. This, in turn, is assumed to be a positive function of the percentage of total returns audited.

PENALTY RATE, δ . For this we use the ratio of the additional taxes, penalties, and interest assessed by the IRS during the year in question, to the amount of taxes evaded. This specification was chosen for two reasons. First, because the U.S. Tax Code specifies different fines for different types of offenses, no single statutory penalty figure can be used. Second, because this measure includes interest charges, it captures the effect of interest rates on the cost of evasion. Penalties are expressed as a percentage of evaded taxes rather than evaded income in order to be consistent with the U.S. practice and with our theoretical model. Since the actual amount of evaded taxes depends on unreported income, the way this variable is constructed may introduce an error-in-variable bias. Therefore, we follow Durbin's [1954] approach for constructing an instrumental variable. This involves ranking the sample in order of the variable measured with error and using this rank order as an instrument.

TAX RATE, Θ . Here we use a weighted average marginal tax rate constructed using a scheme suggested by Wright [1969]. This involves averaging the marginal rates in each year's tax schedule after weighting them by the percentage of total AGI in the corresponding tax bracket.

TRUE INCOME, y . Given that the dependent variable is based on the Adjusted AGI Gap, the appropriate measure of true income is BEA AGI adjusted for the income of those not required to file tax returns. Because the inflation rate is included in the model as a separate variable, we specify true income in real terms. However, using Adjusted BEA AGI as an independent variable may result in simultaneity bias. Therefore, we instrument this variable by regressing it on all exogenous variables in the model, as well as the current and past values of the money stock (M1) and government expenditures. This means that (17) is estimated using the autoregressive analogue of the two-stage least squares procedure.

INFLATION RATE, p . To measure inflation, we use the rate of change of the Consumer Price Index. We also used the Implicit GNP Deflator and obtained results consistent with those reported in (18).

INTEREST RATE, r . Our measure of the rate of interest is an average of the savings and time deposit rate. Because the inflation rate enters equation (17) as a separate explanatory variable, the savings and time deposit rate was converted into real terms by removing from it the inflation rate as defined above. This allows us to capture the pure effect of interest rates on evasion. We also estimated (17) using the three-month Treasury Bill yield, which produced results comparable to those shown in (18).

WAGE AND SALARY SHARE, w . To control for the composition of income, we include the share of wages and salaries in national income as a separate variable in equation (17).

APPENDIX B

DATA SOURCES

The data used in the construction of λ , as well as y , were taken from T.S. Park, "The Relationship Between Personal Income and Adjusted Gross Income, 1947-78", *Survey of Current Business*, November 1981, pp. 24-28, and p. 46, as well as more recent volumes of the *Survey of Current Business*. The data used for calculating Π , and δ , were obtained from Internal Revenue Service, *Annual Report: Commissioner of IRS*, U.S. Government Printing Office, the 1947-81 issues. The data used for constructing θ , as well as the exemption data used to adjust the Gap were taken from Internal Revenue Service, *Statistics of Income - Individual Returns*, U.S. Government Printing Office, the 1947-81 issues. The data for all other variables were obtained from the *Economic Report of the President*, U.S. Government Printing Office, 1984.

Summary: Time Value of Money and Income Tax Evasion Under Risk-averse Behavior: Theoretical Analysis and Empirical Evidence. — This paper examines the effect of interest rates on tax evasion. It begins by developing a simple theoretical model of a risk-averse individual whose evasion decision depends on the interest rate, the probability of detection, the penalty rate, the tax rate, the level of true income, and the price level. Comparative static analysis reveals that the direction of the relationship between interest rates and evasion depends upon attitude towards risk. Under Arrow's Hypothesis of increasing relative risk aversion, it is determined that a direct relationship can be expected from interest rates to the proportion of income underreported. As for the other explanatory variables, results consistent with those reported in previous theoretical literature are obtained. In order to provide additional insight, empirical analysis of aggregate U.S. data covering the period 1947-81 is conducted. The results indicate that evasion and interest rates are indeed directly related. They also support previous empirical findings regarding the relationship between evasion and its other major determinants.

Résumé: La valeur-temps de la monnaie et l'évasion de l'impôt sur le revenu sous un comportement d'aversion au risque: analyse théorique et évidence empirique. — Cet article examine l'effet des taux d'intérêt sur l'évasion fiscale. Il commence en développant un modèle théorique simple d'un individu adverse au risque dont la décision d'évasion dépend du taux d'intérêt, de la probabilité de détection, du taux de pénalité, du taux d'impôt, du niveau du vrai revenu et du niveau des prix. L'analyse statique comparative indique que la direction de la relation entre les taux d'intérêt et l'évasion dépend de l'attitude envers le risque. Sous l'hypothèse d'Arrow d'une aversion relative croissante au risque, l'on détermine que l'on peut s'attendre à une relation directe des taux d'intérêt à la proportion du revenu sous-évalué. En ce qui concerne les autres variables explicatives, l'on obtient des résultats analogues avec ceux mentionnés dans la littérature théorique antérieure. Afin de fournir des informations supplémentaires, nous avons mené une analyse empirique des agrégats relatifs aux Etats-Unis pour la période 1947-1981. Ces résultats indiquent que l'évasion et les taux d'intérêt sont effectivement directement reliés. Ils confirment aussi des résultats empiriques antérieurs à propos des relations entre l'évasion et des autres déterminants majeurs.

Zusammenfassung: *Zeitlicher Wert des Geldes und Einkommensteuervermeidung bei Risikoabneigung: Theoretische Analyse und empirische Evidenz.* — Der Artikel untersucht den Effekt von Zinsen auf Steuervermeidung mittels eines einfachen theoretischen Modells mit einem risikobewußten Individuum, dessen Entscheidung zugunsten der Steuervermeidung von der Höhe der Zinsen, der Wahrscheinlichkeit der Aufdeckung, dem Strafmaß, dem Steuersatz, der Höhe des tatsächlichen Einkommens und dem Preisniveau abhängt. Eine komparativ-statistische Analyse zeigt, daß das Verhältnis zwischen Zinsen und Steuerhinterziehung von der Einstellung zum Risiko abhängt. Arrows Hypothese der zunehmenden relativen Risikoabneigung deutet auf eine direkte Verbindung zwischen Zinsen und nicht-erklärtem Einkommen hin. Hinsichtlich der anderen erklärenden Variablen stimmen die Ergebnisse mit denen früherer theoretischer Arbeiten überein. Darüber hinaus wird eine empirische Analyse aggregierter US-Daten für den Zeitraum 1947-81 durchgeführt, die zu dem Ergebnis kommt, daß Steuervermeidung und Zinsen tatsächlich in direktem Zusammenhang stehen. Sie unterstreicht frühere empirische Untersuchungen im Hinblick auf das Verhältnis zwischen Steuervermeidung und anderen wesentlichen Determinanten.